

WASHINGTON, D. C. 20024

B70 04003

SUBJECT: J-Mission Traverse Planning: The
Implications of Apollo 13 Traverse
Scientific Activities - Case 340

DATE: April 2, 1970

FROM: J. W. Head

ABSTRACT

A series of scientific activities will be carried out on the lunar surface during the EVA 2 traverse of the Apollo 13 mission. These activities and their objectives are examined in order to provide estimates of the type of scientific activity which might be undertaken at science stations on more advanced missions and to document the duration of specific scientific activities for use in J-mission reference mission planning. The implications for J-mission traverse planning are discussed.

(NASA-CR-110572) J-MISSION TRAVERSE
PLANNING - THE IMPLICATIONS OF APOLLO 13
TRAVERSE SCIENTIFIC ACTIVITIES (Bellcomm,
Inc.) 12 P

(THRU)
None
(CODE)

N79-73330

00/91
Unclas
11805

FF No.

(NASA CR OR TMX OR AD NUMBER)

(CATEGORY)

(THRU)
1191
(CODE)



SUBJECT: J-Mission Traverse Planning: The
Implications of Apollo 13 Traverse
Scientific Activities - Case 340

DATE: April 2, 1970

FROM: J. W. Head

MEMORANDUM FOR FILE

Introduction

A series of scientific activities will be carried out on the lunar surface during the EVA 2 traverse of the Apollo 13 mission. The purpose of this memorandum is to outline these scientific activities and their objectives. A second purpose is to provide estimates of the type of scientific activity which might be undertaken at science stations on more advanced missions and to document the duration of specific scientific activities for use in J-mission reference mission planning. The duration of each activity and the extent of involvement of each astronaut is outlined to provide a background for scientific trade-offs which must be made in mission planning (i.e., extent of sample documentation vs. number of samples at a particular science station).

The scientific activities and descriptions of crew involvement are taken from the preliminary Apollo 13 Lunar Surface Procedures document⁽¹⁾. The average times cited with reference to each scientific activity were provided by J. Dietrich/TH2 and represent times derived from crew training exercises.

Typical Documented Sample Collection

The purpose of sample documentation is to place each collected sample into the exact context in which it was found on the lunar surface. This is desirable because the location and position of each sample may be important in terms of exposure ages, crater deposit stratigraphy, or some other relationship. Documented sample collection is carried out at points throughout the traverse and both astronauts participate.

¹ Apollo 13 Lunar Surface Procedures (Preliminary); Prepared by MSC Lunar Surface Operations Office, FCSD, January 30, 1970.

<u>LMP</u>	<u>CDR</u>
PLACE ALHTC (HAND TOOL CARRIER)	PLACE GNOMON IN VICINITY OF SAMPLE (UPSUN)
TAKE 15 FT PHOTO OF SAMPLE & HORIZON"	TAKE STEREO PAIR (CROSS SUN)
PHOTO SAMPLE (DOWNSUN) DEPLOY BAG IN DISPENSER (IF REQUIRED)	COLLECT SAMPLE & DESCRIBE PLACE SAMPLE IN BAG
SEAL BAG & REPORT NUMBER STOW SAMPLE	PHOTO SITE (CROSS SUN) COMMENCE SEARCH NEXT SAMPLE

Full documentation of one sample averages approximately five minutes. For each additional sample taken at a documented sample site, an additional 30 seconds is required, on the average. Obviously, if it is scientifically advisable, considerable EVA time can be saved by multiple sampling at a documented site.

Typical Core Tube Sample Collection

The purpose of core samples is to add a third dimension to the sampling process, to provide a record of possible layering and sequences of events, and to detect changes of all types with depth in the regolith. Core tubes (3) may be taken anywhere during the traverse and are usually taken at areas interpreted as having significant three dimensional aspects, such as through ejecta deposits on crater rims.

<u>LMP</u>	<u>CDR</u>
PLACE ALHTC	PLACE GNOMON UP SUN
ASSEMBLE CORE TUBE/HANDLE REPORT NUMBER & HOLD UPRIGHT ON SURFACE	REMOVE HAMMER FROM HTC DRIVE TUBE INTO SURFACE STOW HAMMER
REMOVE CORE TUBE & CAP	
REMOVE HANDLE & STOW STOW SAMPLE IN HTC	PHOTO TUBE & HORIZON CROSS SUN @ 15 FT PHOTO SITE CROSS SUN (STEREO PAIR)

Taking a single core tube with full photographic documentation averages approximately five minutes. Double core tubes average approximately seven minutes.

Typical Trench Sample Collection

The purpose of trenching and sampling is to examine the geologic and soil mechanics characteristics of the upper several feet of the regolith. Trenching may be done anywhere on the traverse but is most commonly done where discontinuities or differing characteristics are suspected slightly below the surface (i.e., around crater rims).

Two types of trenching may occur during the traverse. Shallow trenching is done throughout the traverse as part of the Field Geology Experiment.

<u>LMP</u>	<u>CDR</u>
PLACE HTC	PLACE GNOMON UP SUN
ASSEMBLE SHOVEL OR SCOOP	PHOTO SITE CROSS SUN
DIG TRENCH 10° OFF DOWN SUN	PHOTO DIG AS REQUIRED
	FILM PROCEDURE WITH SEQ CAMERA
TAKE DOCUMENTED AREA PHOTOS AND SAMPLE FILL, BOTTOM, SIDES DISCONTINUITIES TAKE CSC PHOTOS AS REQUIRED	

The average duration of this activity is five minutes.

The Soil Mechanics investigation also requires trenching. In this case, a specific trenching tool is required and trenching is done at "outpost" to a depth of approximately two feet. These activities are outlined below.

<u>LMP</u>	<u>CDR</u>
PLACE HTC	PLACE GNOMON UP SUN
PHOTO SITE DOWN SUN	PHOTO SITE CROSS SUN
ASSEMBLE TRENCHING TOOL	
RETRIEVE SESC* FROM HTC	DIG TRENCH 10° OFF SUN
	LINE - 2 FT DEEP
OPEN SESC	NOTE: PHOTO STEREO PAIR
PHOTO CDR 16 MM CAM	TAKEN AS PART OF
	DOCUMENTED SAMPLE
REMOVE SEAL PROTECTOR &	FILL SESC WITH SUB-
SEAL SESC	SURFACE MATERIAL
STOW SESC IN HTC	PHOTO TRENCH CROSS SUN
PHOTO TRENCH DWN SUN	PHOTO BOOT PRINT IN FILL
NOTE: TAKE OTHER DOCUMENTED SAMPLES AS REQUIRED	

The average duration of this activity is ten minutes.

Gas Analysis Sample Collection (GASC)

A gas analysis sample will be taken at approximately the point of maximum radius from the LM ("outpost") to avoid contamination. A variety of clean rocks and glasses is desired. This sample is sealed in a special container (GASC) when it is taken.

<u>LMP</u>	<u>CDR</u>
PLACE ALHTC	PLACE GNOMON UP SUN
PHOTO SAMPLE DOWN SUN	PHOTO SAMPLE CORSS SUN
	STEREO PAIR
RETRIEVE SAMPLE CONTAINER (HTC)	
OPEN GASC	COLLECT SAMPLE
	PLACE SAMPLE IN GASC
REMOVE SEAL PROTECTOR	
CLOSE AND SEAL GASC	
STOW SAMPLE IN HTC	PHOTO SITE CROSS SUN

*Special Environmental Sample Container

The average duration for this activity, including photographic documentation, is five minutes

Magnetic Sample Collection

Several documented rocks (crystalline, microbreccia) are collected and placed in a special teflon can at "outpost". These constitute the magnetic sample.

<u>LMP</u>	<u>CDR</u>
PLACE ALHTC	PLACE GNOMON UP SUN
PHOTO SAMPLE DOWN SUN	PHOTO SAMPLE CROSS STEREO PAIR
RETRIEVE SAMPLE CONTAINER (HTC)	COLLECT SAMPLE
OPEN CONTAINER	PLACE SAMPLE IN CONTAINER
REMOVE SEAL PROTECTOR	
CLOSE AND SEAL CONTAINER	
STOW SAMPLE IN HTC	PHOTO SITE CROSS SUN

The average duration for this activity, with photographic documentation, is five minutes.

Lunar Environmental Soil Sample

A lunar environmental soil sample, composed of fine material from the bottom of the Soil Mechanics trench, is taken and documented and sealed in a special container (SESC). The duration of this activity is five minutes and is included in the ten minutes for the trenching part of the Soil Mechanics investigation.

Polarimetric Experiment I

The first part of the polarimetric experiment involves near field polarimetric measurements to provide local calibration data. Photometric property measurements of fine-grained material (undisturbed, disturbed, and compressed) and rocks (undersides, top sides) will be made at "outpost".

LMP

CLOSES OUT Closeup Stereo
Camera (CSC)

CDR

LOCATE ROCKS - OVERTURN ONE
& PLACE GNOMON

KICK UP SURFACE BY ROCK
1 PHOTO DOWN SUN AT 5 FT &
10° PHASE ANGLE

ATTACH POLAR FILTER

OVERTURN ROCK & KICK
UP SURFACE

12 PHOTOS DOWN SUN 5 FT AT
80°, 100°, 120°, 140° PHASE
ANGLE

MOVE TO 90° SUN ANGLE

The duration of this activity on the part of the
CDR is estimated at five minutes.

Other Scientific Activities

In addition to the activities listed above, several other scientific activities are undertaken on the traverse. Five minutes will be reserved for an attempt to retrieve rock chips by sieving regolith material with the ALHT scoop/sieve. The Closeup Stereo Camera (CSC) will be used to document various detailed observations on the lunar surface. Random use of the CSC takes an estimated time of approximately one minute per exposure. When done in conjunction with documented sampling, the time decreases to approximately ten seconds. Finally, full panoramic photography sequences take approximately two minutes. The average time for these scientific activities are summarized in Table 1. The scientific activities at "out-post" are shown in Table 2.

Implications for J-Mission Traverse Planning

The type and duration of scientific activities at J-mission science stations are presently poorly defined. Table 3 presents a summary of a minimum of scientific activities which might be undertaken at a science site and an estimate of their time duration based on crew training averages for H-type missions. Additional time is required at each station for other types of sampling and scientific activity, the amount depending on the local geology of the landing site and the station, and the

requirements. This table does not include any consideration of operational activities or traverse scientific instrumentation and therefore the summary times represent only some fraction of the time necessary at each traverse stop. Preliminary estimates⁽¹⁾ suggest that operational overhead times may range as high as 8-13 minutes for a typical science stop with TV coverage. Traverse scientific instrumentation characteristics will be treated in a forthcoming memorandum by the author and M. T. Yates.

The possibility of approval of a stereo camera for sample documentation in J-missions should not be overlooked. A camera of this type would significantly reduce sample documentation time.

The concept of "outpost" activities in J-missions is not clear at the present time. If it continues to be desirable to spend additional time at the traverse point farthest from the LM, details of these activities will have to be defined and their possible impact on operational constraints studied.

Table 3 suggests that under present methods of sample documentation, the minimum time desirable for scientific activities other than traverse instrumentation at a single science station is not less than seventeen minutes. Since the addition of three documented samples at a site almost doubles the amount of time spent there, some method of reducing the time or amount of documentation (such as a stereo camera) would greatly increase the time available for other scientific activities. This additional time might be spent either in additional sampling at a specific station or in increasing the total number of stations.

In scientifically complex areas such as those planned for exploration on J-missions, science stations will undoubtedly require more than one documented sample. At Marius Hills, for instance, many stations will be designed to investigate the relationships of three distinct volcanic units, and an absolute minimum of three documented samples is required.


J. W. Head

2015-JWH-kmj

Attachments

Tables 1, 2, and 3

(1) J. Slaybaugh, Modular Timeline Elements for Lunar Roving Vehicle Traverse Station Stops, Bellcomm Memorandum for File, B70 03072, March 24, 1970, 4 pp. Category B.

TABLE 1

EVA 2 TRAVERSE SCIENTIFIC ACTIVITIES

<u>SCIENTIFIC ACTIVITY</u>	<u>(CDR AND LMP) AVERAGE DURATION</u>
Documented Sample Collection	0:05
Core Tube Sample Collection	
Single	0:05
Double	0:07
Trench Sample Collection	0:05
Soil Mechanics Trench and Sample	0:10
Gas Analysis Sample Collection	0:05
Magnetic Sample Collection	0:05
Polarimetric Experiment I	0:05 (CDR only)
Polarimetric Experiment II	0:05 (CDR only)

TABLE 2

"OUTPOST" SCIENTIFIC ACTIVITIES

<u>SCIENTIFIC ACTIVITY</u>			<u>DURATION</u>
	CDR	LMP	
Gas Analysis Sample	X	X	0:05
Magnetic Sample	X	X	0:05
Soil Mechanics (Deep Trench)	X	X	0:10
(Documented Samples and Special Environmental Sample)			
Core Tube Sample	X	X	0:05
Polarimetric Experiment I & II	X		0:10

TABLE 3

SUMMARY OF BASIC SCIENTIFIC ACTIVITIES
AT J-MISSION SCIENCE STATIONS*

Documented sample collection	0:05
(present method of documentation) (x no. of samples)	
Core tube sample collection	0:05
Trench sample collection	0:05
Panoramic photography	0:02

*This summary includes only basic scientific activities at a science station. Additional time must be added for other types of sampling and investigations (Table 2) depending on the geology of the landing site and the station, and the requirement.

BELLCOMM, INC.

SUBJECT: J-Mission Traverse Planning: The FROM: J. W. Head
 Implications of Apollo 13 Traverse
 Scientific Activities

DISTRIBUTION LIST

Complete Memorandum to

NASA Headquarters

R. J. Allenby/MAL
D. A. Beattie/MAL
G. P. Chandler/MAO
J. B. Hanley/MAL
T. A. Keegan/MA
B. Milwitzky/MAL
W. T. O'Bryant/MAL
L. R. Scherer/MAL
D. Senich/MAL
R. D. Sheridan/MAO
W. E. Stoney/MA

Manned Spacecraft Center

C. H. Perrine/PD
J. R. Sevier/PD
R. Ward/PD
J. G. Zarcaro/TM

U.S. Geological Survey/Flagstaff

A. H. Chidester
D. P. Elston
T. N. V. Karlstrom
G. A. Swann
G. E. Ulrich

Bellcomm, Inc.

D. R. Anselmo
P. Benjamin
T. A. Bottomley
A. P. Boysen, Jr.
J. O. Cappellari, Jr.
F. El-Baz
D. R. Hagner
W. G. Heffron
J. J. Hibbert
N. W. Hanners
T. B. Hoekstra
B. T. Howard
D. B. James
A. N. Kontaratos

Complete Memorandum to

Bellcomm, Inc. (Cont'd.)

M. Liwshitz
J. A. Llewellyn
J. L. Marshall
K. E. Martersteck
J. Z. Menard
B. G. Niedfeldt
G. T. Orrok
P. E. Reynolds
F. N. Schmidt
P. F. Sennewald
J. Slaybaugh
R. V. Sperry
W. B. Thompson
A. R. Vernon
R. L. Wagner
D. B. Wood
All Members Department 2015
Central Files
Department 1024 File
Library

Abstract Only to

Bellcomm, Inc.

I. M. Ross
J. W. Timko
M. P. Wilson